Principles of Mobile Robotics for Additive Manufacturing in Construction

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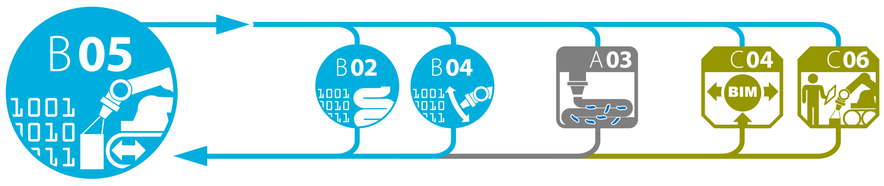
Summary

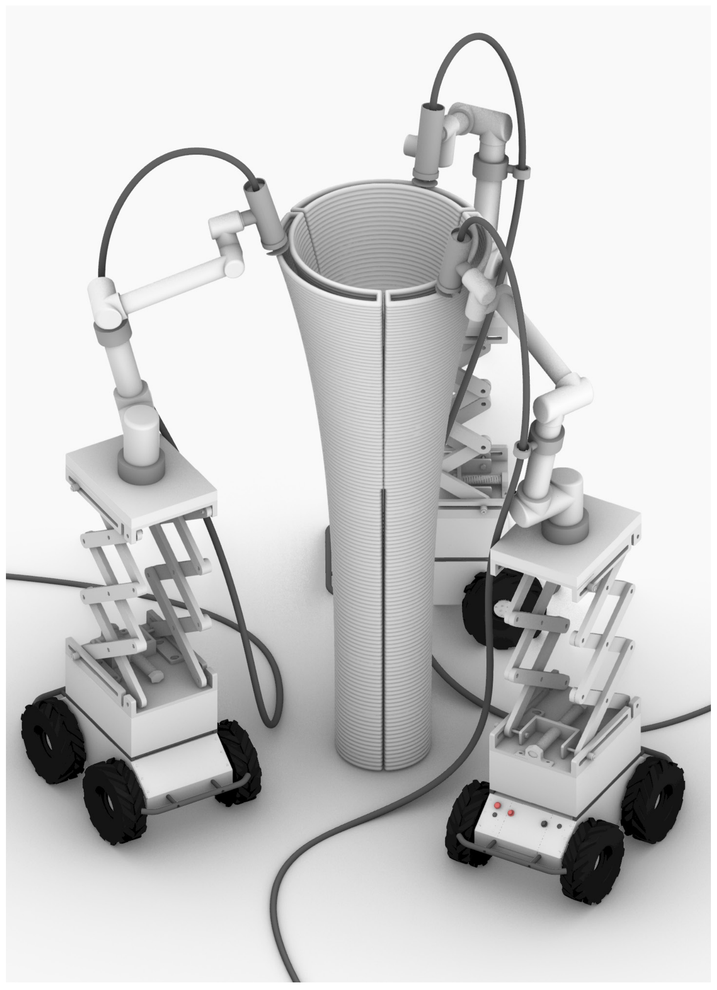


This research examines the architectural implications of mobile robotics for AM in construction and develops methods for their implementation. The material deposition method of concrete extrusion is used to investigate mobile part-based AM strategies to produce large objects whose size exceeds the static workspace of the robot. By implementing advanced sensor and control solutions, autonomous localization and precise manipulation techniques for mobile AM are explored. In addition, this research aims to provide scalability to AM processes by examining the use of cooperative robots to collaborate on single fabrication jobs. The ultimate aim of this research is to develop mobile AM technology for its direct implementation on construction sites.

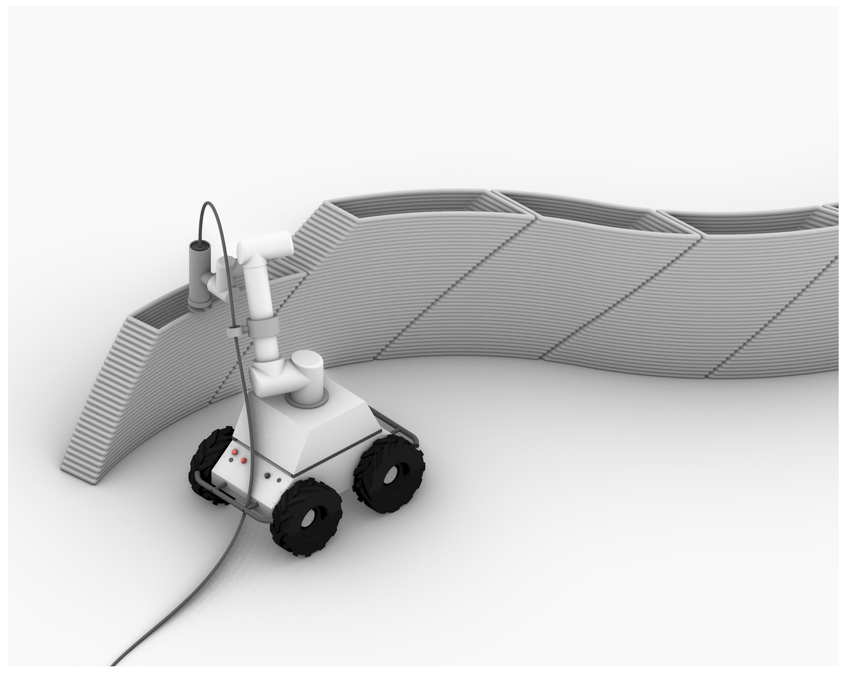
Research Question

This research develops strategies for mobile part-based AM of large objects and it addresses the following questions:

- Can AM processes be expanded to construction sites and what are the potentials that they can bring to in situ concrete construction?
- How can large-scale objects be optimally segmented for their in situ fabrication by mobile robots (by complying with hardening times of the extruded material, structural considerations, workspace limitations, etc.)?
- How can a work piece's absolute accuracy be ensured and material tolerance handled by using a mobile robot across large workspaces?
- How will the design-to-fabrication workflow look like in the future and how can we capture this workflow in the development of the fabrication information models?

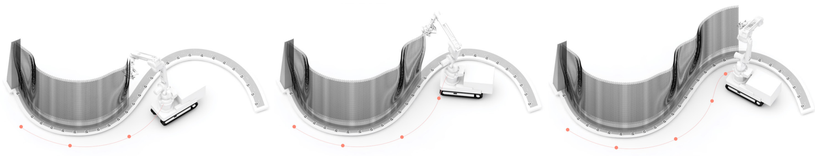


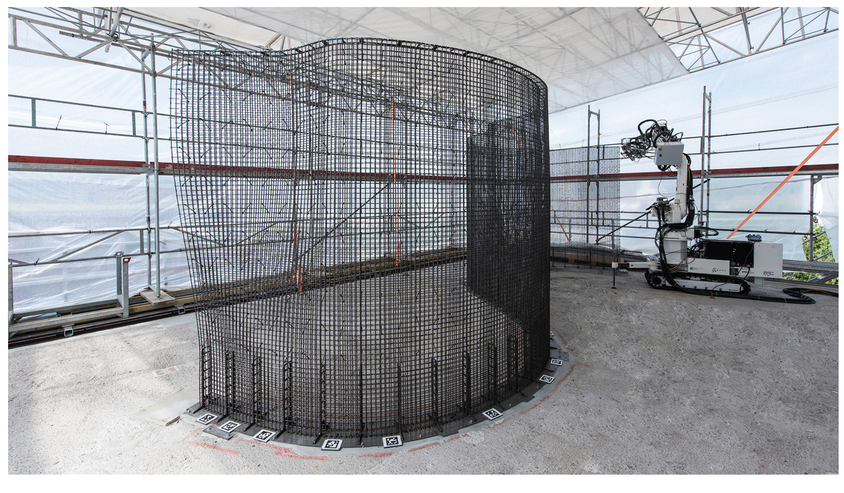
Mobile part-based AM: Fabrication scenarios of a stay-in-place formwork using single and cooperative arm-based mobile robot platforms on site.



Preliminary Work

- Development of the research platform the "In situ Fabricator" at the NCCR Digital Fabrication, ETH Zurich
- Development of robotic on-site fabrication strategies using the mobile robot IF for material systems such as bricks and steel rebar
- Development of sensor-integrated adaptive fabrication processes by establishing geometry-based closed-loop controls
- Close integration of design processes with robotic construction processes





Methods

- Conception and integration of Concrete Extrusion AM technology into mobile robotic platforms (with A03 and B02)
- Development of Fabrication Information Models (FIM) for mobile fabrication, including segmentation and print orientation methods for large objects (with C04)
- Development of a localisation method (with C06), and local sensing and closed-loop control strategy (with B04) for mobile robots in single and cooperative mode
- Validation of the potentials of mobile part based fabrication using single and cooperative robots via the production of demonstrator objects (with A03)